Gender in the Substance of Chemistry, Part 2: An Agenda for Theory

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Abstract: Feminist science criticism has mostly focused on the theories of the life sciences, while the few studies about gender and the physical sciences locate gender in the practice, and not in the theories, of these fields. Arguably, the reason for this asymmetry is that the conceptual and methodological tools developed by (feminist) science studies are not suited to analyze the hard sciences for gender-related values in their content. My central claim is that a conceptual, rather than an empirical, analysis is needed; one should be looking for general metaphysical principles which serve as the conceptual foundation for the scientific theory, and which, in other contexts, constitute the philosophical foundations of a worldview that legitimates social inequalities. This position is not being advocated anywhere in the philosophy of science, but its elements are to be found in Helen Longino's theory of science, and in the social epistemology and ontology of Georg Lukács.

Keywords: *feminist science studies, sociology of scientific knowledge, social epistemology, Helen Longino, standpoint theory, Georg Lukács.*

1. Introduction

The field 'gender and science' is plausibly divided into the following domains: (1) women in science (2) the professional culture of science, and (3) gender ideology in the content of science (Schiebinger 1999). There is a major difference between the life sciences and the physical sciences though, with respect to both the amount and the type of feminist critique that has been published about them. Thus, the life sciences have been subjected to feminist scrutiny on all three accounts; some of their content, especially the scientific construction of women, has been thoroughly and extensively criticized. The feminist critique of the physical sciences, however, has been mostly limited to the women in science issue, *i.e.*, the underrepresentation of women in these fields and the gender discrimination they suffer.

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More recently, and in accordance with the so-called 'practice turn' or 'cultural turn' in science studies in the 1990s and 2000s, some scholars set out to extend the possibilities of analyzing the interrelationship between gender and physics and to go beyond "counting the women"[1] (Gender and Physics Group 2010). They study the everyday interaction, material culture, instruments, public discourse, and systems of meaning that surround and facilitate scientific knowledge production (Traweek 1988, Nägele 1998, Rentetzi 2007, Hasse & Trentemøller 2008, Erlemann 2009, Petterson 2010, Lorenz-Meyer 2012). The programmatic shift from theory to practice seems to imply that gender is to be found in the practice of science, and that the theories themselves are value-neutral. In this view, the question whether the theories of the physical sciences contain gender ideology is the wrong question to ask. Rather than equating science with its theories, feminists would do better to conceptualize science as practice and culture (to borrow the phrase from Pickering 1992). The shift from theory to practice will then enable them to ask different and more productive questions about gender and science (Tanesini 1999, p. 110). Harding seems to make the same point in her 'Why Physics is a Bad Model for Physics' (Harding 1991, pp. 77-102).

I think that it is important to examine the practice of science with historical, sociological, anthropological, and discourse-analytical methods. But it is also important to keep asking the original question, that is, whether the gendered character of scientific knowledge production shows up in the result of this process, *i.e.*, in the scientific theories themselves.

The problem that one encounters when trying to extend the feminist critique of science to the physical sciences is that the analytical tools developed for the feminist critique of the life sciences, mainly targeted at biological theories about men and women, will not be applicable in this domain. In particular, feminist philosophers of science conceptualized gender bias in sex difference research as taking the form of *androcentrism* (Harding 1986, pp. 82-110), *sexism*, *heterosexism*, *gender dimorphism* and *gender essentialism* (Longino 1990, pp. 103-61).[2] It is obviously not possible to find such values in the content of the physical sciences.

It seems then that the asymmetry in feminist science criticism (the focus on theoretical content, in the case of the life sciences, and the focus on scientific practice, in the case of the physical sciences) is the consequence of a conceptual and methodological breach between these two domains of science. Because the physical sciences do not make claims about sex and gender, they evidently cannot contain gender ideology in the same direct form as the life sciences do. Therefore, before one could analyze these fields for (gender) ideology in their content, a conceptual framework is needed which specifies what would count as (gender) ideology in the context of a theory about inanimate nature.

I shall put forward arguments for a method which facilitates the analysis of the physical sciences for gender ideology (and other social ideologies) in their content. My central claim is that one should be looking for general metaphysical principles which serve as the conceptual foundation for the scientific theory, and which, in other contexts, constitute the philosophical foundations of a worldview that legitimates social inequalities. Because of their non-gendered subject matter, physics and chemistry cannot contain gender ideology in the form of sexism, androcentrism, heterosexism, and gender essentialism. Nevertheless, they might be expressive of more general philosophical principles of which the above listed values are particular manifestations. For example, sexism is a special case of hierarchical thinking; gender essentialism is a special case of metaphysical essentialism, and so on.

In the first part of this paper (Kovács 2012), I illustrated the usefulness of this approach with an analysis of the model of the ideal gas in chemical thermodynamics. I argued that this model is based on culturally valenced metaphysical assumptions, namely, Platonic idealism, hierarchy among states of matter, atomism/individualism, and the negligence of interactions between parts and of their embodiment. I argued that these philosophical assumptions, and therefore the resulting theory itself, are value-laden (ideological) both in their origins and in their effects; the general worldview evident in these metaphysical assumptions has implications for both social and natural philosophy, which in turn mutually reinforce each other.

In this essay, I argue for this position on methodological (Section 2) and epistemological (Sections 3 and 4) grounds. I start with a discussion of the sociology of scientific knowledge (SSK), a specialty within science studies that set out to study the impact of social factors on the content of the hard sciences. My argument is that the methodological framework and the epistemology that underlies the choice of method limit the potential of this approach to identify social ideologies in the content of the physical sciences. The problem is that in SSK research, the link between the interests of various social groups and the content of scientific knowledge claims is contingent on the actors' perception of this relationship. Therefore, the proper method to identify ideologies in scientific knowledge is empirical (sociological, ethnographic, or historical). In contrast, I propose that scientific theories necessarily contain social values in the principles of natural philosophy they utilize, and that the ideological content can therefore be identified through a philosophical analysis of these theories. This position is not being put forward anywhere in the philosophy of science, but elements of it are to be found in the theory of science of Helen Longino, and in the social epistemology and ontology of Georg Lukács, which I discuss in Sections 3 and 4.

2. Science studies and the physical sciences

Science and Technology Studies (STS) emerged as an umbrella term for sociology, anthropology, and history of science. The common point that linked these disciplinary based approaches together was social constructivism, the view that scientific facts and technological artifacts are the outcome of various social, cultural, and natural processes.[3] STS had a strong empirical focus and demonstrated, with the help of detailed case studies, how science and technology is thoroughly informed by and entangled with social values and interests.

The major development in the field was to extend the inquiry into the arena of the hard sciences (Pinch & Bijker 1984, p. 401). This focus on the hard sciences can be considered as strategic because it enables one to make the strongest claim possible about the social construction of scientific facts, *i.e.*, to make this claim about sciences whose propositional content is not related to humans or social relations.

Within STS, it is the sociology of scientific knowledge that made scientific knowledge its explicit object of analysis. The tradition was founded by David Bloor, who formulated the so-called 'strong programme' of the sociology of science (1976/91). The central tenets of this manifesto were causality (a genuine sociology of knowledge should examine the psychological, social and cultural factors that cause people to believe in certain statements); impartiality (it should attend to successful (true) as well as to unsuccessful (false) knowledge claims); and symmetry (it should explain both successful and unsuccessful knowledge claims with reference to the same types of causes). The fourth tenet was reflexivity, stipulating that the sociology of science must be applicable to the sociology of science itself. The second and third tenets aim to ensure departure from earlier work in sociology of science, which explained false beliefs with reference to social factors, and true ones with reference to nature (the 'sociology of error'). In the 'strong programme', all knowledge is to be treated as socially constructed, irrespective of its present status.

Social constructivism is a radical challenge and a powerful alternative to scientific realism, and as such, it opens up a theoretical space to address the role of ideology in science. SSK had two major research programs, and both had this goal in mind.

2.1. The Bath school and controversy studies

The Bath school (Harry Collins, Trevor Pinch) took an empirical, micro-oriented approach. Collins (1983) formulated the 'Empirical Programme of Relativism' (EPOR) whose distinguishing characteristic was its focus on contemporary developments in the physical sciences and the study of scientific

controversies in particular. Collins identified three stages in the explanatory goals of EPOR. The first stage was to demonstrate the interpretive flexibility of scientific findings; the second, to describe the social mechanisms that are responsible for theory choice and the third would be to link these closure mechanisms to the broader socio-cultural milieu. Significantly, the latter has not been done yet in any study of contemporary science (Pinch & Bijker 2003, p. 226, n31). In what follows, I shall argue that the inability of EPOR to make this link is rooted in certain aspects of its methodology, namely, its disregard for the ideological content of the scientific theories under examination.

The proponents of EPOR carried out a kind of qualitative (micro)sociology of the scientific community and described scientific controversies in terms of a power struggle between research groups, rooted in conflicting professional interests. They claimed that it was mostly the dynamics of this struggle that determined the closure of the controversy. I believe that for Collins, the crucial task of the sociology of science was to prove that there are extra-scientific factors at play in theory choice. The existence of disagreement in scientific communities was important to him, but he did not pay much attention to the content of the competing knowledge claims. Had the parties in disagreement proposed the opposite positions, Collins' conclusion would have remained the same.

This becomes particularly evident in Collins' much debated statement 'The third wave of science studies' (Collins & Evans 2003), where he makes explicit that his goal with the case studies was to weaken the prestige of science. This goal is motivated by his belief that the exceptional cognitive authority of science is problematic in a democratic society. Interestingly, in the same paper he also declares that only contemporary scientific claims are relative; well-established, long-standing theories of science are beyond suspicion. However, if the outcome of contemporary scientific controversies is determined by extra-scientific factors such as social interests and the professional interests of scientific communities in particular, then surely the scientific claims of the victorious side preserve these interests after becoming part of the scientific canon. The change of status and the passing of time do not eliminate the value-ladenness of the knowledge claims in question.

It seems then that Collins' approach focused on the circumstances of scientific knowledge production and demonstrated the contingent nature of this process. However, he did not consider the content of knowledge claims worth examining. I think this is the ultimate reason why he was not able to attain the third stage in his own program. The same disregard for content nevertheless allowed the proponents of EPOR to focus on the physical sciences because scientific controversy occurs in every branch of science.

2.2 The Edinburgh school and interest theory

In contrast to EPOR, which focused on contemporary science, the Edinburgh school (David Bloor, Barry Barnes, Steven Shapin, Donald MacKenzie, and Steve Woolgar) studied scientific controversies in the past. Dealing with connections between knowledge claims and macro-sociological phenomena, they produced case studies which demonstrated the existence of a certain type of parallelism between the socio-political and the scientific agenda of great men of science. Thus they sought sociological explanation for knowledge claims in terms of the interests of the social groups the scientists belonged to.

Steven Yearley (1982) provides a thoughtful overview and a critique of interest theory. He observes that although many analysts have used interest theory as a theoretical framework for their case studies, it is not very helpful from a methodological point of view because the empirical content of the concepts of 'cognitive interests', 'social interests', and 'interest group' has to be decided anew in every study (*ibid*., p. 362). Although the course and the closure of the controversy are usually explained with the help of traditional sociological conceptions of social class, interest theory does not provide any clue as to which knowledge claims express the interest of which class. This is evident, Yearley claims, in both the case studies and the programmatic writings of the Edinburgh school. Barnes, for example, explicitly opposed Lukács' notion of class-specific knowledge (Barnes 1977, pp. 10-12, 46-49).

This point is crucial in the context of the present discussion on the methodological limitations of SSK. Although interest theory postulates a causal connection between the interest of social groups and the content of the knowledge claims that the members of this group advocate, the two are not intrinsically related. Rather, the connection is contingent on how the group or particular members of it interpret their interests. If, however, interests are taken to be equal to the protagonists' understanding of what their interests are, it is impossible for the analyst to identify any social factors bearing on knowledge claims the protagonists themselves are not aware of.[4]

This explains why Shapin and Schaffer's *Leviathan and the Air-Pump* (1985) is arguably the most convincing case study ever done within SSK. Schaeffer and Shapin studied the 17th century scientific controversy between Robert Boyle and Thomas Hobbes, which ended with Boyle's natural philosophy becoming predominant and Hobbes's views being written out of the history of science entirely. The authors attribute this outcome to the social implications of Boyle's conception of nature, concluding that "solutions to the problem of knowledge are embedded within practical solutions to the problem of social order" (*ibid*., p. 15). What allowed them to make the link between social interests and scientific propositions was that the protagonists

of this story were exceptionally reflexive individuals who made their social and political views explicit in their correspondence and wrote long treatises on political as well as on natural philosophy.

2.3 SSK and gender ideology in the physical sciences

Besides the problem of the imputation of interests that afflicts all SSK, the general gender-blindness of academy creates an additional problem for feminist studies of science. The life and work of Robert Boyle is one of the most widely documented topics in the history of science, with dozens of books and hundreds of articles written on it. Yet it took a feminist philosopher (Potter 2001) to notice that Boyle wrote extensively on gender relations, and that his conversion from one scientific paradigm (hylozoism) to the other (mechanism) was partly motivated by his ideas regarding the proper place of women in society. With this line of argument, Potter made the link between gender ideology and Boyle's gas law, a basic law of physics and chemistry.[5]

Interestingly, Potter's interpretation of her case study imposes the same limitations on the study of values in science as the theoretical framework of the British sociologists. If we are to analyze the technical content of the physical sciences for the gender bias they might contain, Potter says, we should attend not to particular statements such as Boyle's gas law, but rather to the scientific paradigm in which they are embedded. The interpretational context for Boyle's law of gases is the mechanistic paradigm or corpuscular philosophy (*ibid*., ix-x). Potter's analysis of gender and Boyle's gas law is facilitated by her focus on the historical circumstances which motivated his adoption of this paradigm. Significantly, Potter opposes the view that "to show that Kepler's laws presupposed some gender values, feminists would have to prove a necessary or analytic connection between the laws and those gender values" (Potter 1994, p. 102). She suggests instead that students of science direct their attention to the religious and political connotations scientific theories had for their proponents: "whether Kepler's laws contained any values in this sense is a matter of fact to be empirically determined through a case study" (*ibid*.). Just like with SSK, the problem with this methodological position is that the connection between scientific statements and concepts, on the one hand, and cultural values, on the other hand, is to be determined empirically; the value-ladenness of scientific knowledge is contingent on whether the historical actors perceive it as value-laden.

2.4 Lessons from science studies

The case studies of SSK and that of Potter bear important methodological and epistemological lessons. The first is that the unit of analysis should be large enough for the ideological content of a physical science to emerge.

Shapin and Schaffer aimed at understanding the origins of the idea that science be based on experimentation, the main methodological innovation of modern science. Potter inquired into the birth of the mechanistic paradigm, which was its chief conceptual innovation. Also, the historical approach of the Edinburgh school and of Potter had the benefit of hindsight; macro trends are more visible retrospectively, in historical context, than in present time, which was the focus of EPOR.

However, the methodology advocated by the Edinburgh school and by Potter makes it very difficult to identify social ideologies in the theories of the hard sciences, because the success of the analysis is contingent on the parties involved in the controversy being aware of their interests. Underlying this position is a type of social epistemology according to which people's interests are what they say they are. Interests must be investigated empirically, that is, by historical or sociological methods; the analysts can proceed, or so it seems, without any preconception regarding the precise nature of and the interrelationship between social structure, interests, and cultural values. This might look like an advantage to those who aim "to latch the sociology of knowledge into the ongoing general trends of sociological thought" (Barnes 1977, p. 86), or, we might add, onto the ongoing general trends of analytic philosophy.

However, the analysis of the physical sciences for (gender-related) ideologies in their content requires an explicit conceptualization of social structure, social interests, and cultural values, as well as of the relationship between them. The imputation of interests on the basis of first person accounts works only in exceptional cases. In contrast, if interests are taken to emerge from the objective social positions people occupy, and cultural values are linked to these interests, then the value-laden character of scientific theories no longer depends on the actor's subjective interpretations of them. In Potter's words, the connection is necessary or analytic.

In the next two sections, I begin to outline a theoretical position that makes this methodological stance – and thus the philosophical analysis of the physical sciences for gender-related values in their content – possible. Evidently, gender ideology in science is an issue of social values in science, so the conceptualization of interests, values, ideology, and of the relationship between them will be crucial. In other words, the framework needs to be a kind of *social epistemology*. It should also be able to locate these values in the structure of scientific theories, for which a *theory of science* is needed. I find the first in standpoint theory as developed by Georg Lukács, and the second, in contextual empiricism developed by Helen Longino. I start with the second.

3. Contextual empiricism

3.1 Theory of science: the analysis of evidential relations

In her *Science as Social Knowledge* (1990), Longino offers a framework for interpreting gender ideology in sex difference research, and for assessing the role of values in science in general. She argues that the gender bias that feminists have criticized in sex difference research can be conceptualized as gender-related values such as androcentrism, sexism, heteronormativity, and gender essentialism. Consequently, the question of gender bias in science translates to the problem of the role of values in science.

Longino's main concern is to provide an argument to the effect that scientific methodology alone does not guarantee the absence of cultural values from scientific knowledge. The argument is based on an abstract formal analysis of evidential reasoning, *i.e.*, the inference from empirical data to scientific hypotheses or theories. Longino shows that in general, the structure of evidential reasoning is such that any given state of affairs becomes evidence of something else only in light of auxiliary hypotheses, which she calls 'background assumptions'. Contrary to earlier views in the philosophy of science, scientific theories are not based on empirical (experimental and observational) data and logic alone; additional assumptions are needed to attribute meaning and significance to the data and to link them to theoretical hypotheses.

> A given evidential relation may be determined by just one background belief or by a set of assumptions of varying degrees of generality and complexity, but in the absence of any such beliefs no state of affairs will be taken as evidence of any other [Longino 1990, p. 44].

This argument is one version of what is known in the philosophy of science as the underdetermination thesis; *i.e.*, the thesis that a scientific theory is necessarily underdetermined by the evidence that stands in its support, with the consequence that for any given body of empirical evidence, there is always more than one theory that is consistent with it.

Longino goes beyond merely stating the thesis of underdetermination, and proceeds to examine the nature and the origin of the background assumptions that bridge the gap between data and hypothesis. Where do background assumptions come from? First, they might be contextual values, that is, values rooted in the social, cultural, or political context in which the science under consideration is conducted. Second, they might be substantial statements coming from other areas of science. Finally, they might be rules of logic, such as induction, which facilitates generalization from the particular to the universal. Longino's account is unique among the many formulations of the underdetermination argument in that it allows for the possibility

that the logical gap between data and hypotheses is closed by value-laden background assumptions. It thereby allocates a space for contextual, as opposed to constitutive, values[6] in the structure of scientific theories; hence the name *contextual empiricism*.

Background assumption might or might not be conscious to the scientists who rely on them. It is in fact more appropriate, Longino says, "to speak of beliefs when these statements are more or less explicitly adopted as tenets and of assumptions when their necessity to a bit of evidential reasoning is not explicitly acknowledged" (*ibid*., p. 59). The possibility that the ideological character of a piece of science is hidden from its proponents is what distinguishes Longino's analysis of science from the SSK approach. Sociologists of scientific knowledge search for evidence of personal or political motivation behind the scientists' commitment to certain theoretical frameworks. In contrast, Longino's method is to ascertain the necessity of some background assumptions through the analysis of evidential relations in those theoretical frameworks, and to locate the origin of these assumptions in the belief system of the researchers' culture. This method does not require the imputation of interests to individual scientists; they might well be under the influence of wide-spread cultural beliefs or further the interests of their social group without being aware of doing so (Longino 1997a, p. 120).

Commentators often take Longino to say that scientific knowledge is necessarily value-laden (Tanesini 1999, Biddle 2009). Longino is in fact less radical; her argument is for the possibility, and not for the necessity, of the presence of contextual values in scientific theories. Her refrainment from concluding that scientific knowledge is necessarily value-laden is all the more interesting because her own argument provides enough ground for this stronger claim.

A closer examination of the types of background assumptions Longino mentions proves the point. As mentioned above, background assumptions can be either contextual values, substantive statements from other areas of science, or rules of logic. However, the statements from other areas of science can be subjected, in the context of their origin, to the analysis of evidential reasoning offered by Longino. Such analysis will show that in the process of establishing these statements, scientists must have made use of background assumptions, that is, of contextual values, of further substantial statements from yet another field, and/or of induction. From the methodological point of view, this may lead to infinite regress; from the epistemological point of view, it simply means that in the final instance, background assumptions boil down to either contextual values or to the rule of induction.

Longino remarks that the logical empiricist account of the empirical confirmation of scientific hypotheses can be seen as a limiting case describing scientific reasoning when only simple induction is used to link data to hy-

potheses. Induction, however, is not a logically valid rule of inference; it only works if a certain uniformity (with respect to kinds) and regularity (with respect to processes) of the natural world is assumed, and this is a substantial, rather than a purely logical, assumption (Longino 1990, pp. 58-9, n16). It seems then that the analysis of evidential reasoning, taken a bit further than Longino herself does, leads to the conclusion that scientific knowledge is necessarily value-laden.

3.2 Background assumptions as the locus of ideology in scientific theories

Longino distinguishes between two types of background assumptions, depending on their scope (*ibid.*, p. 86-98). The first type facilitates the interpretation of data in specific areas of inquiry. The second type consists of "global, frameworklike assumptions that determine the character of research in an entire field" (*ibid*., p. 86).

Longino's case studies on behavioral neuroendocrinology and human origins, offered as illustrations of her general conceptual framework, are mostly focused on background assumptions that shape these specific areas of inquiry. When discussing SSK research, I argued that the few empirical studies that were successful in finding social ideologies in the physical sciences were about scientific paradigms, most often the mechanistic one. Longino herself illustrates the workings of global assumptions with reference to historical work on the birth of modern science and on the emergence of mechanism, its first coherent paradigm (*ibid*., pp. 92-98).

This might well signify a difference between how social ideologies operate in the life sciences and in the physical sciences. The life sciences make claims about people, among other things, and so they often utilize contextually determined background assumptions about human nature, gender difference, or social relations. These are assumptions that shape their specific areas of inquiry. The subject matter of the physical sciences is, in contrast, non-social; normative ideas about human nature or society cannot feature directly among the background assumptions that facilitate evidential reasoning in these fields. Such ideas might, however, give rise to ideas about the natural world by means of analogy.

The parallelism that SSK research often observed between the social and political agenda and the scientific agenda of scientists of the past is not only a parallelism between socio-political and scientific goals, but also one between ways of seeing the social world and the natural world. "Explanation and understanding, in science as anywhere else, involves conceptualising the unfamiliar in terms of the familiar", and such processes "inevitably generate isomorphisms between different sub-systems of meanings within a culture"

(Barnes 1977, p. 35). That is to say, ideas about the organization of people might well serve as heuristic devices for formulating explanatory schemes regarding the organization of matter.

Because such analogies are on a relatively high level of abstraction, they affect the most fundamental metaphysical assumptions utilized by the theories of the physical sciences. Among all sciences, it is the theories of the hard sciences that lay down the foundations of the scientific worldview; they are therefore likely to contain background assumptions of a very fundamental and general kind. We might call these assumptions principles of natural philosophy. These 'general framework-like assumptions' shape the entire paradigm of the age, rather than particular theories only. This explains why all the successful case studies on the value-ladenness of the physical sciences were historical in nature: if the unit of analysis is the scientific paradigm, rather than particular theories within it, then the time-frame of the analysis also needs to be bigger.

This raises the question of whether it is possible to analyses social ideologies in the physical sciences with a philosophical, rather than historical, method. In Section 3.4, I shall argue that it is, but only in an epistemological framework that postulates the necessity, rather than only the possibility, of the reliance of scientific theories on socially valenced background assumptions.

3.3 Some remarks on Longino's social epistemology

In contextual empiricism, the theory of science is coupled with a social theory of knowledge which is outlined in *Science as Social Knowledge* (Longino 1990, pp. 62-82) and elaborated in more detail in Longino's second book *The Fate of Knowledge* (2002). The point of departure for Longino's social epistemology is the theory of science described in the previous section. Because scientific methodology does not automatically eliminate the influence of social values, their elimination can only take place through intersubjective criticism, that is, the critique of scientific hypotheses from as many viewpoints as possible. Since background assumptions are transparent to people who hold them, criticism can only come from other individuals for whom these assumptions are not self-evident and who therefore can point out their presence in scientific theories. Therefore, critical discursive interaction and the social organization of scientific inquiry that facilitates this discourse acquire epistemic significance.

This gives rise to a procedural definition of objectivity: what distinguishes knowledge from belief is that it has been subjected to critical scrutiny and modified in response to or defended against the objections of other qualified members of the community. Traditional views define objectivity as a relation

between knowledge and its intended object; Longino defines it as the characteristic of the process in which it was created, erasing any reference to truth or reality.

Interestingly, although the diversity of viewpoints is seen as an epistemic resource, the origin of this diversity goes unexplained. The framework does not inquire into the formation of viewpoints and values; analysis starts at the point when individuals already hold them. Underlying Longino's social epistemology is a liberal view of human rationality, where individuals are seen as the best experts of their own interests, and the theorist is not justified in imputing interests or value judgements to them.[7] The consequence for the analysis of scientific knowledge is that the values identified behind the background assumptions in scientific theories cannot be said to be congruent with or antithetical to the interests of social groups unless and until some members of these groups explicitly advocate or problematize them.

This limitation becomes particularly evident in Longino's naturalized approach to feminist epistemology. When Kuhn established his theory that the history of science is the succession of incommensurable paradigms, he wanted to offer some criteria that make theory choice seem rational nevertheless. He proposed empirical adequacy, simplicity, internal coherence, consistency with other theories, breadth of scope, and fruitfulness as legitimate criteria for theory choice (Kuhn 1977). Longino identifies an alternative set (empirical adequacy, novelty, ontological heterogeneity, complexity of relationship, applicability to current human needs, and diffusion of power) that is somehow the opposite of the traditional one (Longino 1997b). She observes that the socio-political nature of the feminist virtues cast doubt on the alleged value-neutrality of the traditional set. If the feminist virtues serve feminist cognitive goals, that is, they help to produce knowledge that can contribute to the abolition of gender inequality, then the cognitive goals of mainstream science are domination and control (*ibid.*, p. 28).

Was modern science aimed at domination and control before feminists, Marxists, and ecologists voiced this criticism in the second half of the 20th century? Was it thereby partial, value-laden and less objective, in the sense of catering to the needs of the few, instead of the needs of the many? Surely it was, but on Longino's account, it was not. Her social epistemology stipulates that objectivity is a function of the extent to which knowledge claims have been transformed or defended against real or anticipated criticism. But there was no feminist, Marxist, or ecologist criticism of these public standards at the time when they emerged; nor could the founding fathers of modern science have transformed their methodologies and substantial assumptions in anticipation of the criticism of social movements that first appeared 300 years after their death.

3.4 Contextual empiricism and the physical sciences

Longino's theory of science marks an immense step toward analyzing scientific knowledge for social ideologies in their content, and creates the possibility of performing this analysis by philosophical, rather than social scientific methods. One encounters two problems though when trying to apply her framework to the theories of the physical sciences.

The first is that for such an analysis to be both philosophical and successful, the necessity, rather than the mere possibility, of the value-ladenness of scientific knowledge must be assumed. On Longino's account, the scientific theory needs to be dissected and its elements sorted out into three categories: empirical evidence, inferences drawn from these, and additional assumptions without which the inferences would not have been possible. This requires a detailed (and because of the time scale, historical) reconstruction of the entire experimental background of the theory in question. If on the other hand the necessity of the presence of contextual values in scientific theories is established through a general or conceptual argument – and I think it is possible to read Longino's work along these lines – then the challenge for the analyst of any particular piece of science becomes to identify *what* value-laden assumptions are being relied on, without also having to establish their status as ideology.

Second, the worldview elements so identified must be somehow linked to gender so that they acquire the status of *gender* ideology. It is not easy to formulate why Longino's approach is problematic in this respect. For in one sense, the feminist virtues offer some idea as to what a feminist science would look like in terms of content. Nevertheless, Longino's general approach to social epistemology is such that it recognizes viewpoints only when and as they are articulated, ignoring the historical nature of ideologies.

The gradual evolvement of feminist thought over time is a case in point. Certain historical and cultural developments in the Western world led to the birth of the women's movement in the 18th century. By the middle of the 20th century, feminists developed critical perspectives on the social sciences and humanities, and finally, from the 1970s on, a feminist critique of the life sciences was articulated in North America. Longino's list of the feminist virtues is a descriptive selection of normative reflections of feminist biologists in the United States. At this point in history, feminist consciousness has not yet reached the point of formulating a critique of the content of the hard sciences. Surely, this does not mean that women have no stakes in the physical sciences; it only means that the link between women's interests, on the one hand, and the values found in the theories of these fields, on the other, has to be made by the philosophical framework.

4. Marxist and feminist standpoint theory

In order to establish the claim that certain values found in the theories of the physical sciences are gendered, an alternative epistemological framework is needed. Traditionally, the alternative to empiricism as a theory of knowledge is Marxist epistemology, also known as standpoint theory. The writings of Marx provide grounds for the claim that the two main classes in capitalism (the *bourgeoisie* and the proletariat) have distinctive viewpoints on reality. The systematic philosophical elaboration of this view is to be found in the work of Georg Lukács. Feminist standpoint theory was developed by means of analogy between the position of women under patriarchy and the position of the proletariat under capitalism. This section examines Marxist and feminist standpoint theory for their potential to conceptualize social ideologies in the physical sciences.

4.1 The nature of a standpoint

Standpoint theory maintains that (1) social positions provide their members with a specific perspective onto reality, and that (2) some standpoints are epistemically privileged over others.

Feminist standpoint theory has often been taken to claim that women have special 'ways of knowing' and that the epistemic privilege of the feminist standpoint is rooted in the superiority of their attitudes (such as intuition, holism, emotional engagement with the object of knowledge, and so on) over traditional approaches to knowledge. In this interpretation, the standpoint is a subject position, the mindset of an individual. In contrast, Lukács's original formulation postulates an analytic or necessary connection between the content of the standpoint of a people and the objective conditions of these people's lives:[8]

> [c]lass consciousness consists in fact of the appropriate and rational reactions 'imputed' [zugerechnet] to a particular typical position in the process of production. This consciousness is, therefore, neither the sum nor the average of what is thought or felt by the single individuals who make up the class [Lukács 1924/71, p. 51].

Consequently, group membership is neither necessary nor sufficient condition for having access to the standpoint of the group.

The difference between class position and class standing is especially evident in the case of Marxist standpoint theory. Marx lived on the revenues of Engels' textile factory, and Lukács was the son of one of the wealthiest investment bankers of the Austro-Hungarian Monarchy. Yet through starting analysis from the lives of social classes other than their own, they were able to develop alternatives to bourgeois economics and liberal thought.

The fact that all feminist standpoint theorists were women makes this point less perspicuous in the case of feminist standpoint theory, but the point has in fact been made. To start with, the difference between the mindsets of members of the epistemically privileged social group and the perspective attributed to them by analysts is made explicit in the term 'feminist' (instead of female) standpoint.[9] The feminist standpoint is not equal to the experience of being a woman; rather, it is a way of making sense of this experience, and as such, it is also available to men. The feminist standpoint results from a critical and collectively achieved reflection on gender inequality (Hennessy 1993, pp. 67-99).

In *History and Class Consciousness* (HCC) Lukács offered four arguments for the epistemic privilege of the standpoint of the proletariat: (1) its oppression; (2) its central role in production; (3) its productive interaction with the material environment; and (4) the universal character of its interest in overcoming oppressive social relations. The first and the last are related to inequality, while the second and the third have to do with labor, which carries epistemic weight in a materialist worldview.

In the writing of North-American feminists, the epistemic privilege of women/feminists is variously rooted in women's oppression (Smith 1974/1996, Harding 1986, 1991, 1998), in women's work (Hartsock 1983/1998, Rose 1987), in women's cognitive style (Hartsock 1983/1998, Rose 1987; Keller 1985, pp. 95-126), or in a combination of these. The notion of a specifically feminine cognitive style comes from feminist object relations theory, which describes the development of stereotypical feminine and masculine traits in a psychoanalytic fashion. The feminist standpoint is then understood as a subject position which is somehow the consequence of (anatomical) sexual difference. This is clearly untenable as it compromises the most important achievement of feminist theory, *i.e.*, woman as a social rather than as a biological category. The only version that completely avoids this pitfall is Harding's standpoint theory where the epistemic privilege rests with the marginalized groups: women, working class, ethnic and racial minorities, and the global South (Harding 1998). Marginality allows the members of these groups (and whoever is sympathetic to them) to recognize the true nature of oppressive social relations, but there is no argument as to its significance for understanding inanimate nature, the subject matter of the physical sciences.

4.2 Standpoint theory and the physical sciences

The main difficulty in extending standpoint theory to the physical sciences is that the epistemic privilege claimed for systematically disadvantaged groups concerns fundamental questions of history, economics, and society (for Marxists), and gender relations (for feminists). It is unclear whether there are

class- or gender-specific standpoints on inanimate nature and whether some of these are epistemically better than others. In HCC, Lukács himself argued against objective dialectics and thus limited the scope of the epistemic privilege of the proletariat to the social world. This limitation is based on what he at that time perceived as a difference between the two domains, *i.e.*, society and nature:

> [t]he crucial determinants of dialectics – the interaction of subject and object, the unity of theory and practice, the historical changes in the reality underlying the categories as the root cause of changes in thought, etc. – are absent from our knowledge of nature [Lukács 1924/71, p. 24, n6].

How are we to interpret this remark? In issues pertaining to history, society and social change, the subject and object of knowledge interact. Social classes come to know social reality through changing it and in order to change it, while this action itself is facilitated and shaped by their understanding of social relations. Thus there is a dialectic relationship (mutually transformative interaction between entities that change over time) between social consciousness and social reality. In contrast, people stand apart from the objects of the natural world which they strive to know through science. Further, while society changes over time, the objects found in inanimate nature do not.

Lukács later renounced this position as fundamentally mistaken,[10] and toward the end of his life, he set out to rethink Marxism from an ontological point of view, and to develop a unified perspective on the social and the natural worlds.

We have seen that the possibility of class- or gender-specific standpoints on social reality rests on a theory of society from which the content of a standpoint can be analytically derived. In other words, standpoint theory as a social epistemology relies on a social ontology, *i.e.*, empirically based theoretical claims about social structure and social life. Similarly, to be able to claim the existence of class- or gender-specific standpoints on nature, a theory of that natural world should be spelled out first. In other words, an ontology of the natural world is needed against which the content of various standpoints can be evaluated. This is exactly what Lukács accomplished in his last, unfinished work, *The Ontology of Social Being* (1967/78).[11] The detailed description and analysis of this voluminous work that extends over 1400 pages is beyond the scope of present essay; I shall restrict myself to a brief outline of its main ideas, and then indicate how this ontological perspective facilitates the extension of standpoint theory to the physical sciences.[12]

Lukács distinguishes between three forms of being: inorganic, organic, and social, which represent successive stages in the organization of matter. These various domains are qualitatively different and yet connected, because they evolve from one another and because the existence of more advanced

forms is conditioned on their interaction with the previous ones. Importantly, all three forms change over time, albeit at a different rate.[13] Organic nature is different from inorganic one because organisms reproduce themselves; they adapt to their environment (the inorganic world) in a passive way. Humans, in contrast, adapt to their environment (the inorganic and the organic world) in an active way, through the deployment of labor. Labor is the central category of social being; it explains both its origins (human evolution) and its current characteristics (the relations of production).[14] Labor is teleological positing, in which humans harness the causal mechanism of nature to achieve their goals with respect to survival and other human needs. As humans interact with the natural world through labor, labor is the mediator between the two spheres; it is the only mediator, and it is universal in that all fundamental characteristics of social being can be explained with reference to it.

While the conceptualization of the three domains of being is an argument for the metaphysical unity of the world, the concept of labor in the *Ontology* has a radical import for the epistemology of the natural sciences. Contrary to his position in HCC, in the *Ontology* Lukács argues that people come to know the natural world through actively engaging with it. All forms of knowledge emerge through abstraction, comparison and generalization of the experiences acquired in the labor process. This is as true of the stone-axe as of the nuclear plant; theoretical natural science and other forms of knowledge are not different in kind. The view that all knowledge is rooted in and aimed at the improvement of human praxis means that the theories of the natural sciences stand in the same relation to human consciousness as our knowledge of the social world.

The idea of the unity of the social and the natural worlds facilitates the extension of standpoint theory to the physical sciences. If people perceive reality as unified, they will then base their ideas about natural relations on their experiences of social relations. If reality is in fact unified, this then forms a basis for establishing the superiority of some standpoints over others, thus avoiding epistemological relativism. For if the two domains are structured by the same principles, whoever has privileged access to one is in a better position to get to know the other as well.

5. Conclusion

Both science studies methodologies and feminist work on gender and the physical sciences are predicated on the assumption that in order to qualify as a case of (gender) ideology in science, the causal role of this ideology in the

genesis or acceptance of the scientific theory should be demonstrated. In contrast, my analysis of chemical thermodynamics as presented in the first part of this paper (Kovács 2012) suggests that scientists can and do represent cultural ideologies in their work irrespective of their being aware of it. In other words, the values that can be identified in knowledge claims are intrinsically linked to the interests of certain social groups and the connection does not depend on how scientists interpret their own interests or whether they are aware of them. This also means that the method to find these ideologies in the physical sciences is philosophical, rather than historical or sociological; it requires an analysis of the conceptual structure of the theories, and – in the case of gender ideology – further elaboration of what the goals of feminism are and what values are in harmony or in opposition to it.

A social epistemology that is consistent with the claim that the theories of the physical sciences are necessarily value-laden needs to establish an inherent connection between social structure, social interests, and cultural values. This is best done in a Marxist framework, which considers society to consist of social classes or social groups, rather than of individuals. As the consequence of the social division of labor, the social world is structured differently for these groups, which gives rise to group-specific standpoints. The social interests of the groups manifest themselves in value systems (cultural ideologies) that shape their respective standpoints.

The very same cultural ideologies also shape the basic metaphysical commitments of scientific theories. Technically, this is possible in virtue of the underdetermination of scientific theories by data, with the consequence that scientists are bound to rely on extra-scientific considerations or background assumptions when constructing them. These background assumptions designate the locus of cultural ideologies in scientific theories. Background assumptions can incorporate cultural values in a direct form (as in the life sciences), or in an indirect form, *i.e.*, in the form of principles of natural philosophy (as in the physical sciences). Underlying this claim is the theory of science of Helen Longino and an epistemological and an ontological argument – both derived from Georg Lukács – as to the unity of the social and natural worlds both in reality and in people's minds.

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My title echoes that of Catharine MacKinnon's famous essay (1983), in appreciation of her fine work.

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Notes

1 This is the informal term of Elvira Scheich, the initiator of the Gender and Physics Group.

2 Sexism is the view that women are inferior to men, or that they are naturally suited for and therefore properly confined to traditional gender roles. Androcentrism is used to denote the view that men and their lives are more important and deserve more attention than women and women's lives. Heteronormativity or heterosexism is the view that heterosexuality is the normal sexual orientation; when stated on the psychological level, it usually comes with the idea of the complementarity of the sexes. Gender essentialism is the view that women and men have a fixed nature.

3 The traditional views are scientific realism and technological determinism, according to which science discovers pre-existing truths about nature, and technological developments determine social change, rather than the other way round. Scientific realism and technological determinism presuppose a unidirectional causal effect between science/technology and society, whereas social constructivism works with a model of mutual shaping.

4 See Lynch 1994 for a similar reading of the concepts of interest and ideology in SSK.

5 The ideal gas law, the subject matter of the first part of my paper (Kovács 2012), was created by a combination of four empirical gas laws, the earliest of which was Boyle's law.

[6] In *Science as Social Knowledge*, Longino distinguished between constitutive and contextual (or epistemic and non-epistemic) values in science (1990, pp. 4-7). Constitutive values (such as accuracy, simplicity, predictive power, internal coherence, consistency with other theories, and breadth of scope) serve as criteria for theory choice and they are thus necessarily part of the scientific mindset. On this account, the value neutrality of science consists in the freedom of scientific knowledge from contextual (personal, cultural, political *etc*.) values. Longino later reconsidered the distinction, arguing that the constitutive values, too, are socio-political in nature (Longino 1996). Her later work on the feminist virtues, cited in the first part of this paper (Kovács 2012, pp. 113-114) and in Section 3.3 of the present one, is based on this recognition.

[7] For such a characterization of the liberal understanding of rationality, see Jaggar 1983, pp. 27-50.

[8] It was precisely this non-empirical nature of the standpoint that invited Barnes' criticism of Lukács, which I mention in Section 2.2.

[9] Just as most members of the working class are not Marxists, most women are not feminists; yet feminist theory claims to have arrived at a better understanding of women's situation than women themselves have achieved.

[10] See Lukács's declaration in Fetscher 1962, pp. 221-2, cited in Hermann 1974, p. 135-6.

[11] Although the *Ontology* comprises both social and natural ontology, Lukács's main concern remained the first, hence the title.

[12] The relevance of the concept of labor in Lukács's *Ontology* for the conceptualization of social ideologies in the content of the physical sciences was suggested to me by László Ropolyi. The ideas outlined in this section were first developed in a co-authored paper presented at the IAPh conference in 2010.

[13] Geological systems change on the time scale of billions of years. Organic life evolves over millions of years, and the history of humankind is a matter of thousands of years.

[14] In a Marxist framework, economy is the key to the understanding of society. Socio-economic formations are characterized by relations of production (and reproduction), which always involve a division of labor between social classes and between men and women.

References

Barnes, B.: 1977, *Interests and the Growth of Knowledge*, London: Routledge and Keagan Paul.

Biddle, J. B.: 2009, 'Advocates or Unencumbered Selves? On the Role of Political Liberalism in Longino's Contextual Empiricism', *Philosophy of Science*, **76**, 612-23.

Bloor, D.: 1976/91, *Knowledge and Social Imagery*, Chicago: University of Chicago Press.

Collins, H.M.: 1983, 'An Empirical Relativist Programme in the Sociology of Scientific Knowledge', in: K.D. Knorr-Cetina & M. Mulkay (eds.), *Science Ob-*

served: Perspectives on the Social Study of Science, London: Beverly Hills & New Delhi: Sage, pp. 85-113.
Collins, H.M. & Evans, R.: 2003, 'The Third Wave of Science Studies: Studies of Expertise and Experience', *Social Studies of Science*, **32**, 235-96.
Erlemann, M.: 2009, *Menschenscheue Genies und suspekte Exotinnen – Die Ko-Konstruktion von Physik und Geschlecht in öffentlichen Diskursen* [Unsocial men of genius and suspect rare females – the co-construction of physics and gender in public discourse], Ph.D. dissertation, University of Vienna.
Fetscher, I.: 1962, *Der Marxismus: Seine Geschichte in Dokumenten* [Marxism: its history in documents], Munich: Piper.
Gender & Physics Group, 2010, *Mission statement*, [http://www.genna.gender.uu.se/themes/physics/, accessed on 10 October 2010].
Harding, S.: 1986, *The Science Question in Feminism*, Ithaca & London: Cornell University Press.
Harding, S.: 1991, *Whose Science? Whose Knowledge?,* Milton Keynes: Open University Press.
Harding, S.: 1998, *Is Science Multicultural? Postcolonialisms, Feminisms, and Epistemologies*, Bloomington & Indiana: Indiana University Press.
Hartsock, N.: 1983/98, 'The Feminist Standpoint: Developing the Ground for a Specifically Feminist Historical Materialism', in N. Hartsock, *The Feminist Standpoint Revisited and other Essays*, Boulder & Oxford: Westview Press, pp. 105-32.
Hasse, C. & Trentemøller, S.: 2008, *Break the Pattern! A Critical Enquiry into Three Scientific Workplace Cultures: Hercules, Caretakers and Worker Bees*, Tartu: Tartu University Press.
Hennessy, R.: 1993, *Materialist Feminism and the Politics of Discourse*, London & New York: Routledge.
Hermann, I.: 1974, *Lukács György gondolatvilága* [Georg Lukács's thought], Budapest: Magvetö.
Jaggar, A.M: 1983, *Feminist Politics and Human Nature*, Totowa, Rowman & Allanheld.
Keller, E.F.: 1985, *Reflections on Gender and Science*, New Haven & London: Yale University Press.
Kovács, Á.: 2012, 'Gender in the Substance of Chemistry, Part 1: The Ideal Gas', *Hyle: International Journal for Philosophy of Chemistry*, **18** (2), 95-120.
Kuhn, T.: 1977, 'Objectivity, Value Judgment, and Theory Choice', in: T. Kuhn, *The Essential Tension,* Chicago: University of Chicago Press, pp. 320-39.
Longino, H.E.: 1990, *Science as Social Knowledge: Values and Objectivity in Scientific Inquiry*, Princeton: Princeton University Press.
Longino, H.E.: 1996, 'Cognitive and Non-Cognitive Values in Science: Rethinking the Dichotomy', in: L.H. Nelson & J. Nelson (eds.), *Feminism, Science, and the Philosophy of Science*, London: Kluwer, pp. 39-58.
Longino, H.E.: 1997a, 'Interpretation versus Explanation in the Critique of Science', *Science in Context*, **10**, 113-28.
Longino, H.: 1997b, 'Feminist Epistemology as a Local Epistemology – I.', *Proceedings of the Aristotelian Society*, *Supplementary Volumes*, **71**, 19-35.
Longino, H.: 2002, *The Fate of Knowledge*, Princeton: Princeton University Press.
Lorenz-Meyer, D.: 2009, '*Visceral Gendering: Gender Matters in Academic Chemistry*', paper presented at the 7th European Feminist Research Conference, 4 June 2009, Utrecht, Netherlands.
Lukács, G.: 1923/71, *History and Class Consciousness: Studies in Marxist Dialectics*, transl. by R. Livingstone, Cambridge: MIT Press.

Lukács, G.: 1969/78, *The Ontology of Social Being*, trans. by D. Fernbach, London: Merlin Press.
Lynch, W.: 1994, 'Ideology and the Sociology of Scientific Knowledge', *Social Studies of Science*, **24**, 197-227.
MacKinnon, C.A.: 1983, 'Feminism, Marxism, Method and the State: An Agenda for Theory', *Signs*, **8**, 635-58.
Nägele, B.: 1998, *Von "Mädchen" und "Kollegen": Zum Geschlechterverhältnis am Fachbereich Chemie* [Of 'girls' and 'colleagues': on gender relations in chemical research], Mössingen-Talheim: Talheimer Verlag.
Pettersson, H.: 2010, *Boundaries, Believers, and Bodies: A Cultural Analysis of a Multidisciplinary Research Community*, Saarbrücken: Lambert Academic Publishing.
Pickering, A. (ed.): 1992, *Science as Practice and Culture*, Chicago: University of Chicago Press.
Pinch, T.J. & Bijker, W.E.: 1984, 'The Social Construction of Facts and Artefacts: Or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other', *Social Studies of Science*, **14**, 399-441.
Pinch, T.J. & Bijker, W.E.: 2003, 'The Social Construction of Facts and Artifacts', in: C. Scharff & V. Dusek (eds.), *Philosophy of Technology: The Technological Condition. An Anthology*, London: Blackwell, pp. 211-29.
Potter, E.: 1994, 'Methodological Norms in Traditional and Feminist Philosophy of Science', PSA, **1994** (2), 101-8.
Potter, E.: 2001, *Gender and Boyle's Law of Gases*, Bloomington & Indianapolis: Indiana University Press.
Rentetzi, M.: 2007: *Trafficking Materials and Gendered Experimental Practices: Radium Research in Early 20th Century Vienna*, e-book, Columbia University Press [online: http://www.gutenberg-e.org/rentetzi/].
Rose, H.: 1987, 'Hand, Brain, and Heart: A Feminist Epistemology for the Natural Sciences', in: S. Harding & J.F. O'Barr (eds.), *Sex and Scientific Inquiry*, Chicago & London: University of Chicago Press, pp. 265-82.
Schiebinger, L.: 1999, *Has Feminism Changed Science?* Cambridge & London: Harvard University Press.
Shapin, S. & Schaffer, S.: 1985, *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life*, Princeton: Princeton University Press.
Smith, D.E.: 1974/96, 'Women's Perspective as a Radical Critique of Sociology', in: E.F. Keller & H.E. Longino (eds.), *Feminism and Science*, Oxford: Oxford University Press, pp. 17-27.
Tanesini, A.: 1999, 'Feminist Empiricism', in: A. Tanesini, *Introduction to Feminist Epistemologies*, Malden, Blackwell, pp. 95-113.
Traweek, S.: 1988, *Beamtimes and Lifetimes: The World of High Energy Physicists*, Cambridge & London: Harvard University Press.
Yearley, S.: 1982, 'The Relationship Between Epistemological and Sociological Cognitive Interests: Some Ambiguities Underlying the Use of Interest Theory in the Study of Scientific Knowledge', *Studies in History and Philosophy of Science*, **13**, 353-88.

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